INSTRUMENT SHOP

Statham INSTRUMENTS

OPERATING INSTRUCTION MANUAL
FOR
TEMPERATURE TEST CHAMBER

Models TC 2, 4, 6, & 8

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Statham

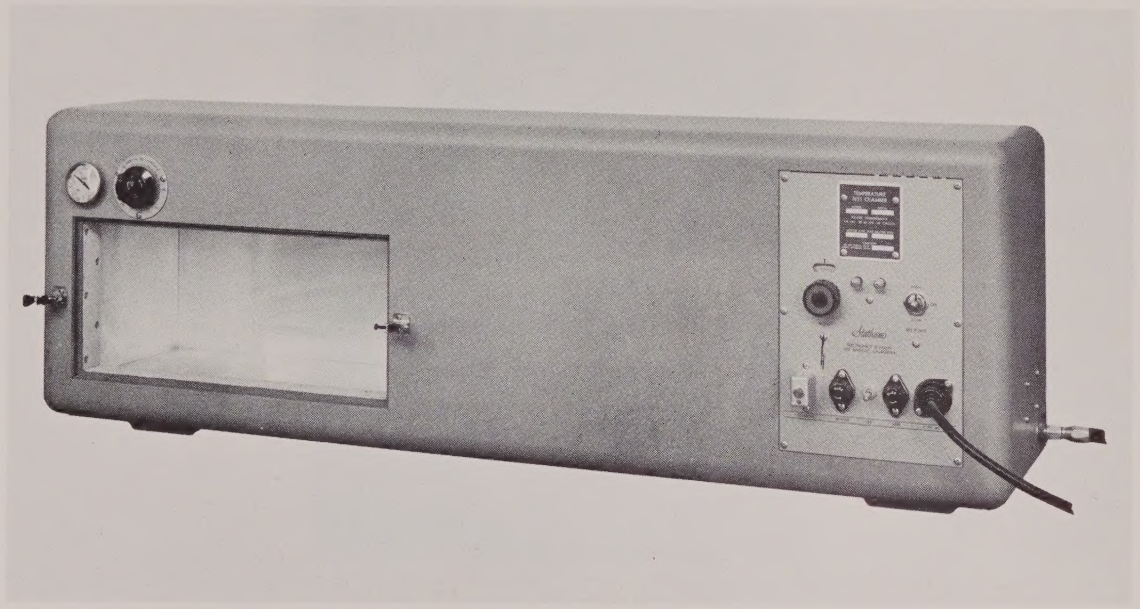
ENVIRONMENTAL & TEST EQUIPMENT

OPERATING INSTRUCTION MANUAL
FOR
TEMPERATURE TEST CHAMBER

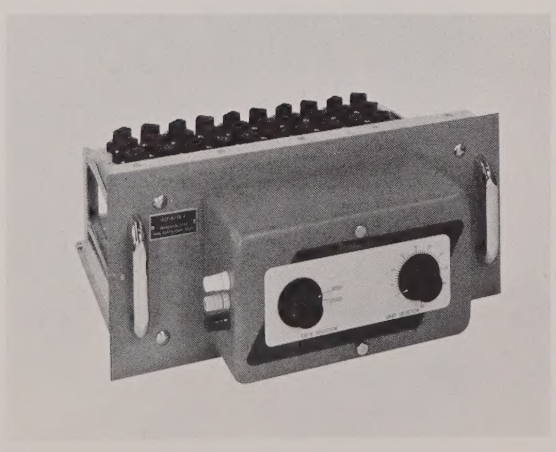
Models TC 2, 4, 6, & 8

THIS MANUAL COVERS THE FOLLOWING MODELS

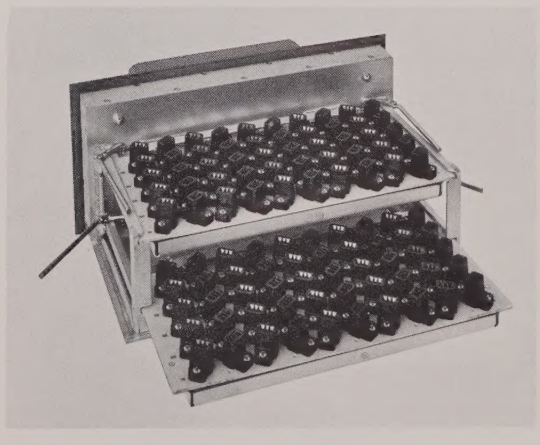
MODEL	FROM S/N UP
TC-2A	2-240
TC-2B	2-240
TC-4A	4-183
TC-4B	4-183
TC-6A	6-211
TC-6B	6-211
TC-8A	8-212
TC-8B	8-212



TC — 2B Temperature Chamber
(17″ door and liquid CO_2 inlet)

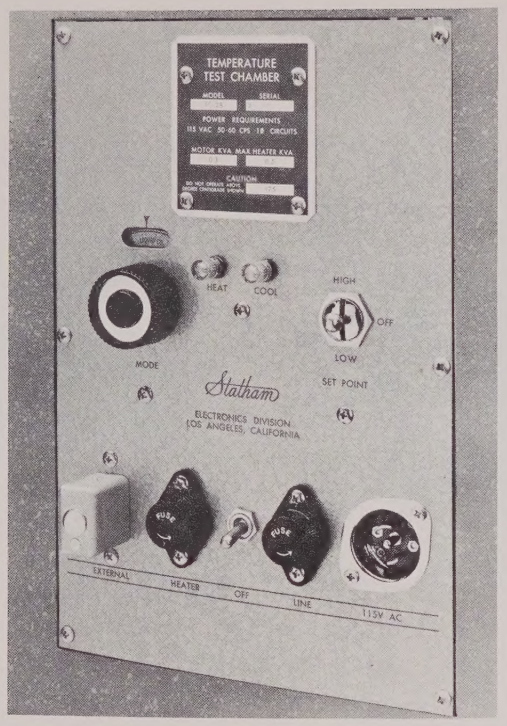


Front View

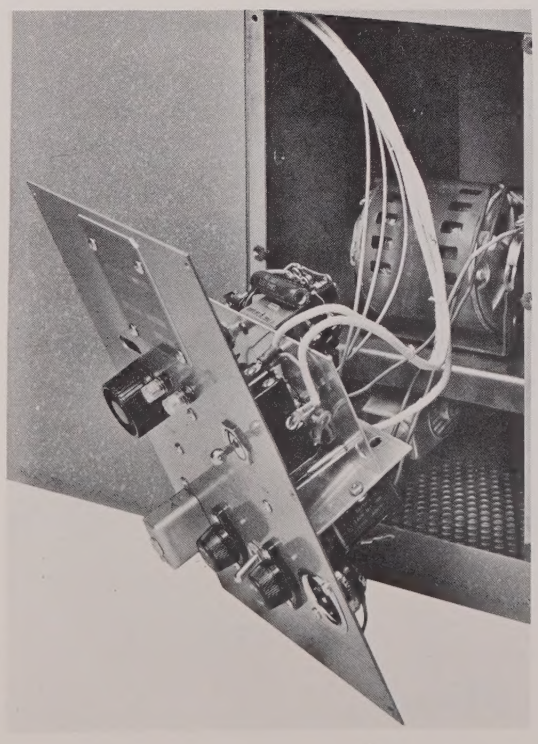


Rear View

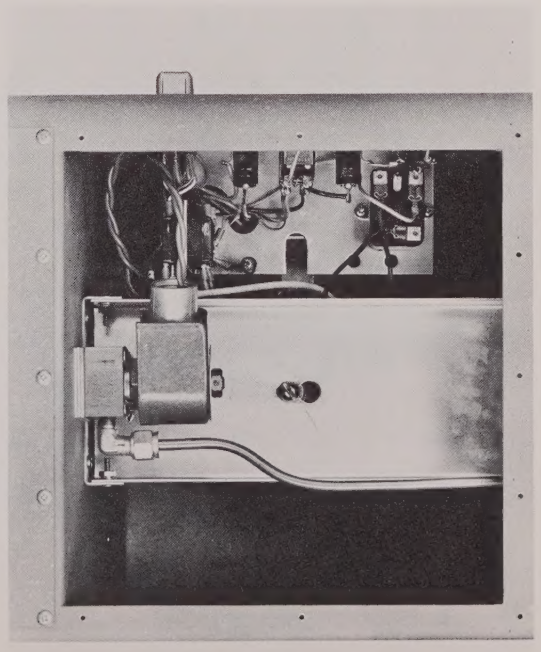
TCT — 4/TR — E Transistor Test Fixture
with Transistor Shelves TCS-TR-E



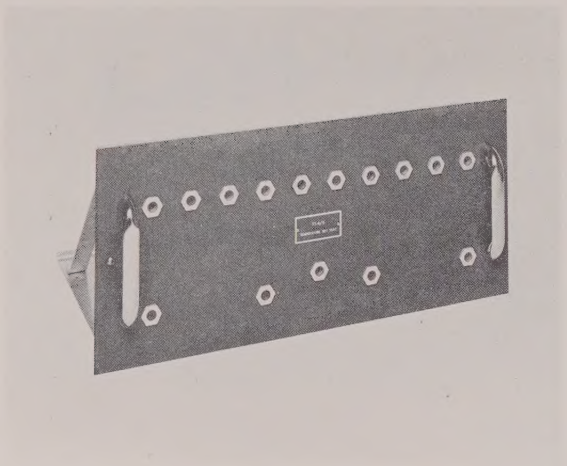
TC Control Panel
(TC 2 Shown)



TC Motor Compartment
and Control Panel

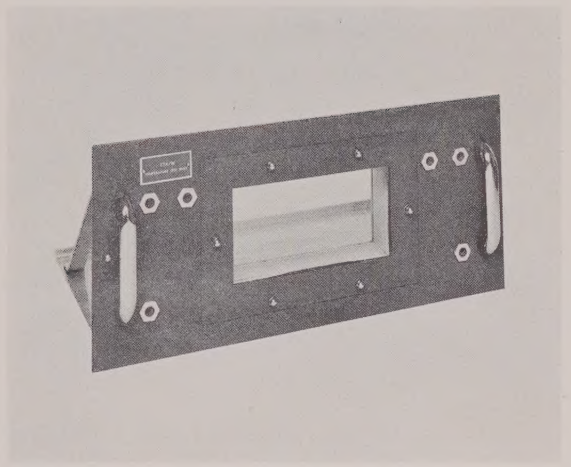


TC Liquid CO_2
Inlet and Control Valve



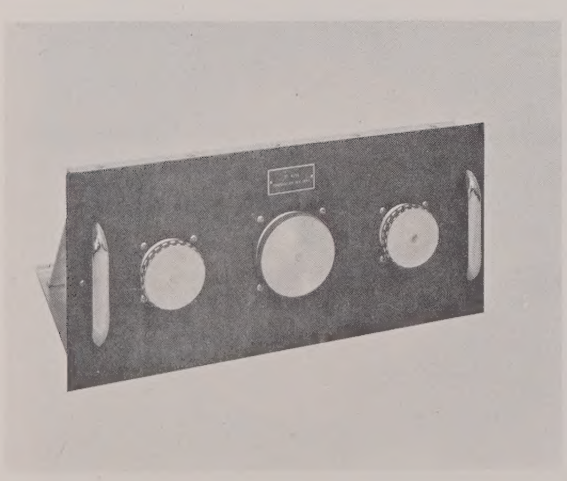
TT-4/s

Standard Tray
(with thru-holes)



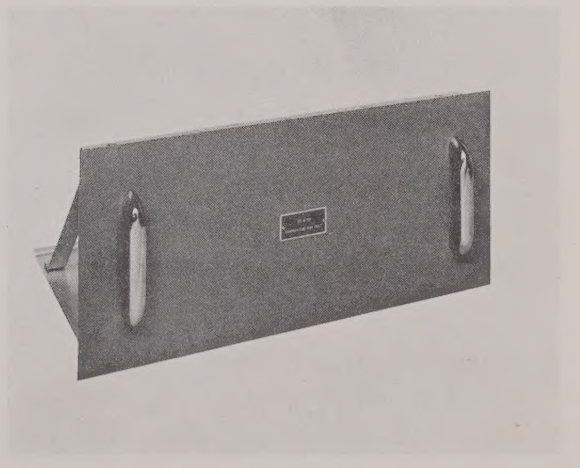
TT-4/w

Window Tray
(with thru-holes)



TT-4/h

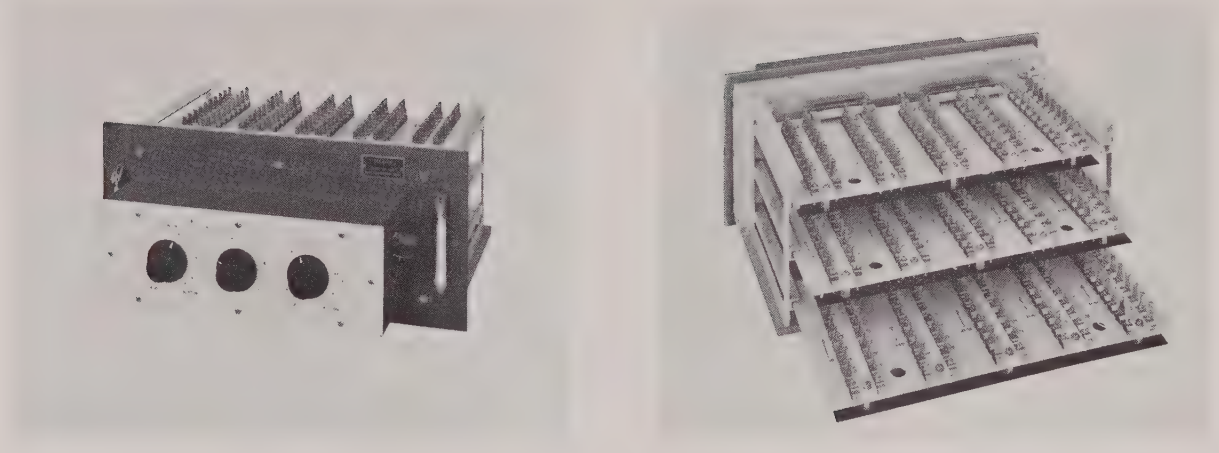
Cable Connector



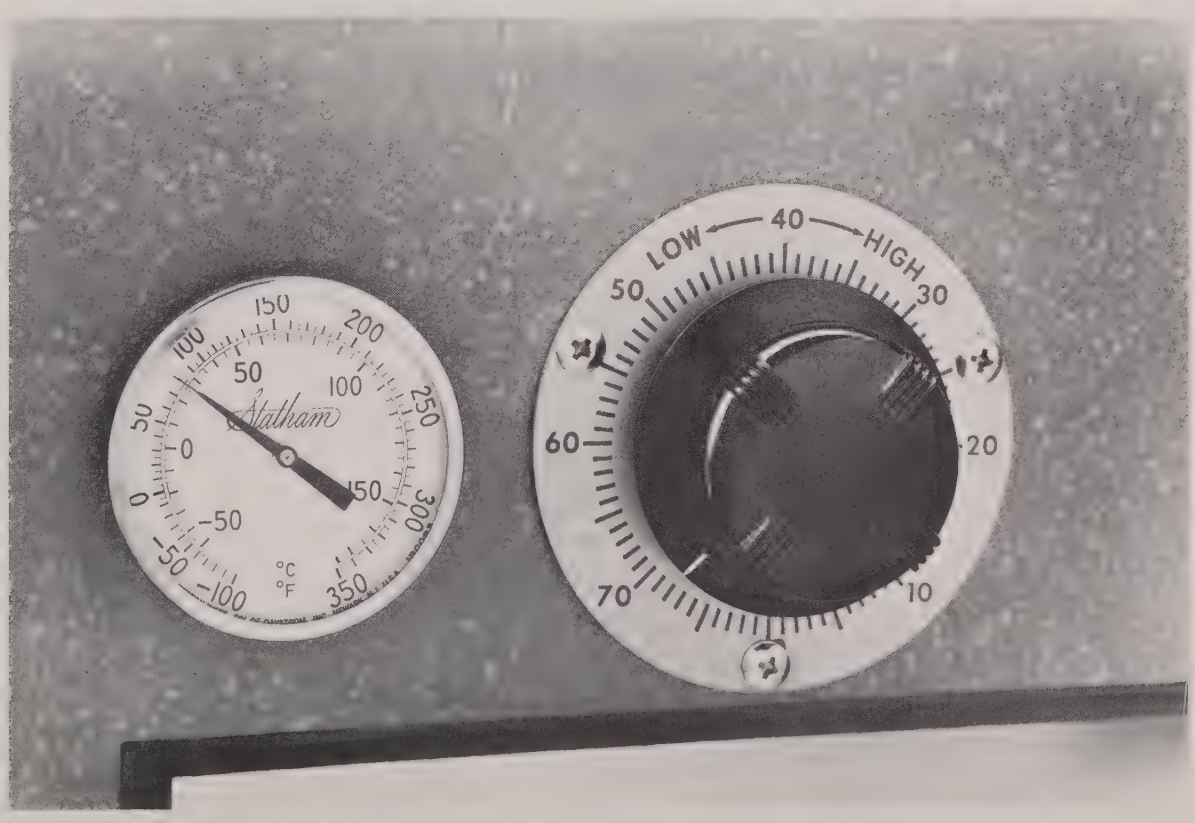
TT-4/O

Blank Tray

*For TC-8 Models, specify TT-8 with same /no.



TCT-4CR Diode Test Tray
with Shelves TCS — 4/CR



TC Controller & Indicator
Note: Temp. Conversion Direct on
Dial Thermometer

TABLE OF CONTENTS

1.0 PRINCIPLE OF OPERATION

- 1.1 Airflow
- 1.2 Heating Cycle
- 1.3 Cooling Cycle
  - 1.31 Cooling using Solid CO_2
  - 1.32 Cooling using Liquid CO_2
  - 1.33 Cooling using Liquid and Solid CO_2

2.0 OPERATING INSTRUCTIONS

- 2.1 Controls
  - (1) Thermoswitch
  - (2) Thermometer
  - (3) Mode
  - (4) Set Point
  - (5) Power On-Off
- 2.2 Operation
  - 2.21 Heating
  - 2.22 Cooling using Solid CO_2
  - 2.23 Cooling using Liquid CO_2
  - 2.24 Cooling using Liquid and Solid CO_2
- 2.3 External Cycling

3.0 MAINTENANCE

- 3.1 Insulation
- 3.2 Motor
- 3.3 Thermoswitch
- 3.4 Relay

4.0 CONTROL CIRCUIT

- 4.1 Description
- 4.2 Schematic Drawing

5.0 TROUBLE SHOOTING CHART

6.0 TABLE OF REPLACEABLE PARTS

7.0 SCHEMATIC DRAWING

8.0 TECHNICAL NOTES

1.0 PRINCIPLE OF OPERATION

Many industries are now manufacturing items that must be tested at temperatures as high as +320°C (600°F) and at temperatures as low as -70°C (-100°F). To provide a test facility that is inexpensive, accurate and flexible; electric strip heaters, combined with carbon dioxide (solid or liquid) are ideal for rapid temperature testing of devices. By the proper design, it is possible to utilize these advantages and apply them to a closed system testing chamber which provides air flow as the means of effecting heat transfer to or from a test object. The Statham TC Series Temperature Test Chambers are an example of this type of portable device.

1.1 Air Flow

The operation of the test chamber is illustrated in Figure 1. Air is circulated continuously in a closed path past the test load. Heat is transferred either to or from the test load by means of the circulating air stream. Heat is added to the air stream, when required, by means of electrical heaters. Heat is extracted from the air stream by the sublimation of solid carbon dioxide or liquid carbon dioxide or both. In this manner, when appropriately controlled, any selected temperature between -70°C and +320°C may be maintained depending on the temperature range of the particular chamber under consideration. The control system in the TC-2, TC-4, TC-6, and TC-8 Temperature Test Chambers is an anticipator controller and is capable of accurate control of the temperature of the circulating air stream. A heating device and an adjustable thermoswitch are employed in such a fashion that anticipator action is achieved. This anticipator action holds the thermostat in a ready condition most of the time and provides a rapid ON-OFF action, thus reducing the peak excursions of temperature about a desired set point.

1.2 Heating Cycle

Heating Cycle Heat is added to the chamber by means of an electrical strip heater. The heat control switch marked SET POINT on the front control panel allows for the control of the strip heater. When in the high position, the maximum amount of heat is available to the system and should be used only when operating in an elevated temperature region (near the upper limit of the device), while the low position should be used at an intermediate region between ambient and maximum.

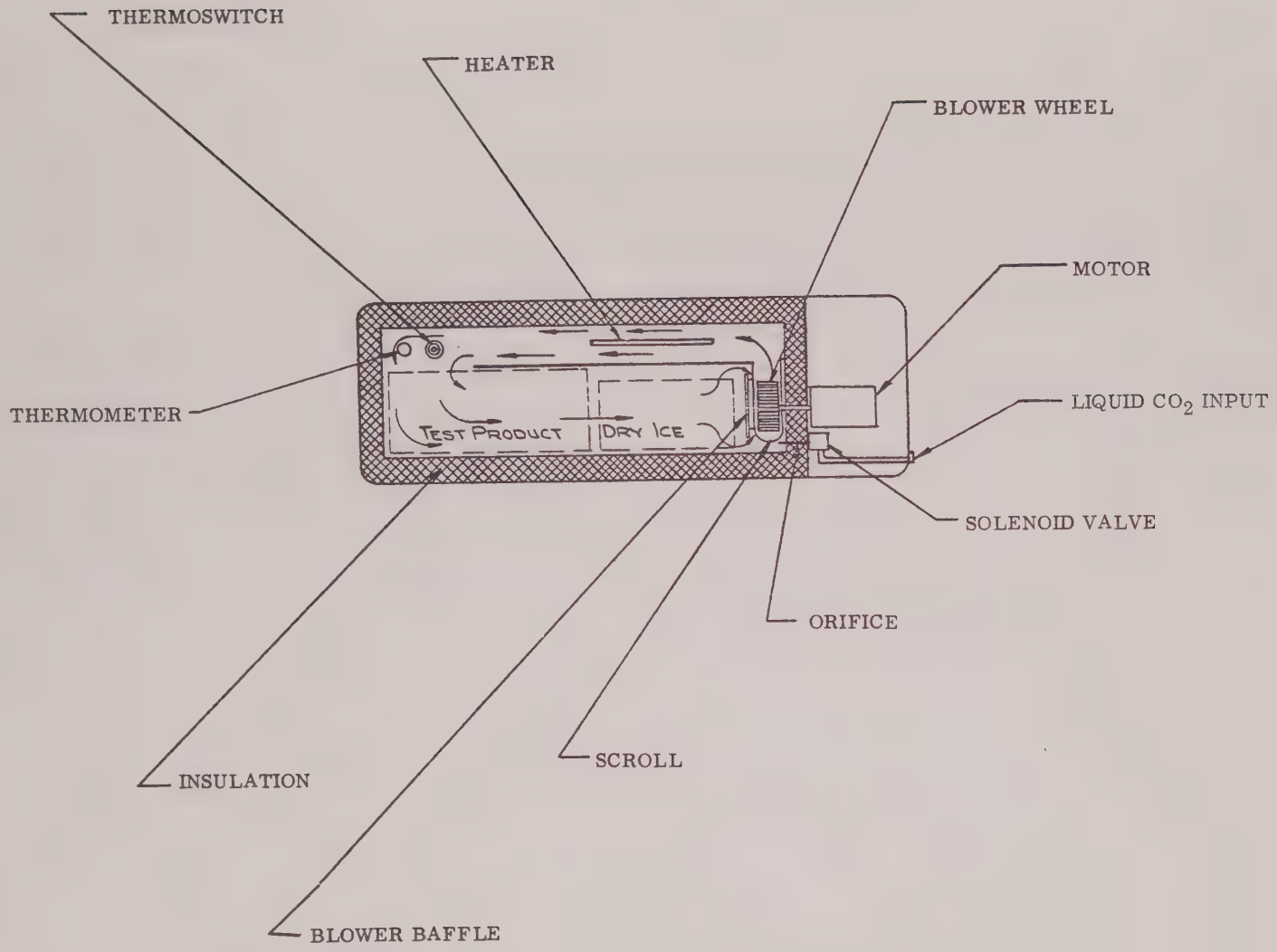


FIGURE 1 AIRFLOW DIAGRAM

1.2 Heating Cycle (continued)

Temperature Range	Set Point Setting
Ambient to 2/3 Range	Low
2/3 Range to Full Range	High

These settings do not apply when the test load is a heat source. The correct adjustment for such cases must be determined by trial; however, bear in mind that the low setting given above utilizes 1/4 of the available rated power of the device. For example, a TC-2 is a 500 watt maximum heat load device and the low setting, of course, indicates 125 watts of input power is available. Thus, when 100 watts of heat are available from the test product and the test product is being tested at 350°F, it is apparent that the low position should be used rather than the high position. Best results are achieved when the main heater is energized approximately 50% of the time. Therefore, if ON periods greatly exceed OFF periods at the stabilized temperature, a higher set point heat selection is indicated, and vice versa. To reduce the time required to heat the chamber, the SET POINT should be "HIGH" and then adjusted to a lower setting just before the chamber reaches the desired temperature.

CAUTION: The maximum recommended temperature of the test chambers is shown in the chart below, and is also indicated on the nameplate of the chamber. Sustained operation above this temperature can result in damage to the test chamber components. Short term over ranging has not indicated damage to the chamber; however, individual judgment must be exercised to prevent damage.

Model	Maximum Temperature Rating	
	°C	°F
TC-2 & TC-6	+175	+350
TC-4 & TC-8	+320	+600

1.3 Cooling Cycle

Solid and liquid carbon dioxide is utilized in the Statham Temperature Test Chambers as an inexpensive, flexible, clean and expendable refrigerant. Solid carbon dioxide is readily available in most locations. It is commercially available in block or slab form. Fifty pounds is a normal commercial minimum amount. Size of such a package is approximately ten inches cubed. The temperature of solid CO_2 is -110°F (-78.9°C).

1.3 Cooling Cycle (continued)

The solid CO_2 has a refrigeration capacity of approximately 246 BTU per pound when sublimated from a solid to a gas at 110°F. High pressure liquid carbon dioxide is available at most locations where liquid CO_2 is available. The high pressure liquid exists in pressure vessels at ambient temperature conditions. At 70°F, the corresponding pressure is 838 psi. The high pressure liquid CO_2 has a refrigeration capacity of 70 BTU per pound when it is expanded to a gas at atmospheric pressure and -100°F. High pressure liquid CO_2 can be supplied from two basic types of containers; cylinders (syphon type) and liquifiers.

1.31 Cooling using Solid CO_2

Cooling using solid carbon dioxide is relatively straight forward. Solid CO_2 is held in a pan located in the region noted in Figure 1. In the TC-2 and TC-4 Models, the solid CO_2 capacity is approximately 15 pounds; while the same amount can be inserted into the TC-6 and TC-8 Models in a portion of the test space; however, the TC-6 and TC-8 Chambers are not generally used for solid CO_2 operation. For cold runs, the pan is loaded with about 15 pounds of solid CO_2. For extremely low temperature operation where maximum cooling rate is necessary, cut the solid CO_2 into slabs about an inch thick and place on edge in a direction parallel to the length of the pan. Make sure that the slabs are separated to expose as much surface as possible to the circulating air. For moderately low temperatures, the cooling rate may be reduced if the solid CO_2 is left in one piece. For further reduction of cooling rate, cover the solid CO_2 with an insulating cloth. In applying coverings, care must be taken to prevent blocking air circulation within the chamber. When inserting dry ice, make sure that it goes far enough to the right so that it does not interfere with the installation of the test tray. During low temperature testing over an extended period of time, additional solid CO_2 may be inserted into the chamber by means of removing the test tray.

NOTE: The SET POINT is in the LOW position, so that heat is added to the system. This results in a "bucking" action, so that a control point is maintained.

1.32 Cooling using Liquid CO_2

Liquid CO_2 is injected into the chamber, when cooling is desired, by means of an electric

1.32 Cooling using Liquid CO_2 (continued)

solenoid valve. When the adjustable thermoswitch is not calling for heat, the control action of calling for liquid CO_2 is derived from a control relay. High pressure liquid CO_2, when injected through an orifice (Figure 1) is expanded to a gas recovering approximately 70 BTU/pound. It is noted that a syphon type bottle is required for the delivery of the liquid to the chamber. No regulators or valves (other than the bottle valve) are required to operate the chamber. The test load is placed so that a free flow of air can occur around it, and the chamber is connected to a liquid CO_2 source. Care must be taken to carefully seal all openings, where CO_2 may escape so that the CO_2 use is reduced. An ON period of approximately 6 seconds, at the extreme low end of temperature (-100°F) is normal, while the OFF period is approximately 30 seconds.

1.33 Cooling using Liquid and Solid CO_2 in Combination

It is indicated that the advantage of liquid CO_2 (rapid draw-down time) can be employed in conjunction with solid CO_2, in such a fashion that the solid CO_2 acts as a fast draw-down coolant. Temperature control, of course, can be maintained in the same fashion by injecting liquid CO_2 when required, even though the chamber is loaded with solid CO_2.

2.0 OPERATING INSTRUCTIONS

The TC-2, TC-4, TC-6, and TC-8 Temperature Test Chambers are anticipator type devices, controlled by a thermoswitch with an anticipator heater which predicts the temperature rise and keeps the thermoswitch on the edge of control. Adjustment of this thermoswitch is the means of controlling the temperature of the air stream within the chamber. It is possible to determine the ambient temperature of the chamber by means of observing the thermometer, then adjusting the thermoswitch until the heat pilot operates (if the MODE switch is on a positive range and the SET POINT switch is in either LOW or HIGH position). The heat pilot is energized when power is being supplied to the heaters. After the ambient point is determined, the chamber can be utilized for either heating or cooling.

NOTE: Turn thermoswitch clockwise to increase heat.

2.1 Controls

The thermoswitch is the controlling device for the successful operation of the chamber. The thermometer

2.1 Controls (continued)

is utilized to determine both the operating temperature of the chamber and the operating point relative to the thermoswitch. The MODE control determines whether the chamber is used for a heating cycle or a cooling cycle, the latter being subdivided into two categories; solid CO_2 or liquid CO_2.

The SET POINT adjustment determines the amount of heat (watts) to be added when a heating cycle is in operation or when solid CO_2 is used as a coolant. The power switch controls input power to the chamber. Pilots for HEAT and COOL are utilized. Fuses are provided in accordance with the following chart; their rating is chosen for maximum protection on a normal 115 volt, 50-60 cycle, single phase circuit. Fuses are Buss Fusetron type FNM or equal.

Model	Line (Amperes)	Heater (Amperes)
TC-2	8	7
TC-4	20	15
TC-6	8	7
TC-8	20	15

2.2 Operation

Connect the test chamber to any 115 volt, 50-60 cycle outlet capable of supplying at least the power required. The test tray should be removed and the test articles should be loaded on the test tray so as to provide maximum surface exposure to the circulating air stream. Lead-in cables or mechanical connections may be installed through corks pressed firmly into the test tray openings. All unused openings should be plugged on both sides. If the mechanical connection has a rotating or reciprocating member, a lubricant suitable for the test temperature may be applied to the bearing surface of the cork.

2.21 Heating

If the operating temperature falls within the zones indicated on the chart below, for the specific model under consideration, the set point switch should be set to the position indicated. If the test unit is a heat source, certain precautions must be taken and lower settings must be employed. In the event the test temperature is above, but near ambient and the product is a

2.21 Heating (continued)

heat source, it will be necessary to operate the chamber as for a cooling cycle. The most efficient and accurate stabilization is achieved when the main heater is energized 50% of the time. If the ON periods greatly exceed the OFF periods at the stabilized temperature, a higher heat selection is indicated and vice versa.

Model	Set Point	
	High (watts)	Low (watts)
TC-2	500	250
TC-4	1500	750
TC-6	500	250
TC-8	1500	750

For setting an elevated temperature, it is necessary to determine the operating ambient within the chamber. Switching the power switch to the ON position energizes the motor circuit and air circulation commences. An immediate determination of the chamber ambient can be made. This is done by positioning the SET POINT switch to either heat position and rotating the thermoswitch to its extreme counterclockwise position, then rotating it clockwise about two turns, the HEAT pilot should assume the ON position and a slight click will be heard. This click is the heater control relay operating. When advancing the thermoswitch, caution must be observed not to exceed the stop setting on either end of rotation. After determining the room ambient temperature, approximately 90°F (33°C) per rotation is the calibration factor for either a heat increase or decrease. When the appropriate number of clockwise turns have been added to the room ambient, the chamber will then control at this approximate set point. To achieve greater heating rate, it is advisable to position the SET POINT switch in the HIGH position and observe temperature as it increases then reducing the SET POINT to the low heat range. After operating temperature has been reached, the ON-OFF cycle examined and the SET POINT placed in its proper position, nothing more need be done with respect to operating the chamber.

2.22 Cooling using Solid CO_2

As a preliminary measure, if possible, pre-cool the chamber with an initial load of solid CO_2 in advance of the planned test so that the insulation may have heat extracted from it. For extremely low operating temperatures where maximum cooling rate is necessary, the solid CO_2 should be in slabs approximately 1 inch thick and placed on edge in a direction parallel to the length of the pan. The slabs should

2.22 Cooling using Solid CO (continued)

be separated to expose as much surface as possible to the circulating air. For moderately low temperatures, the cooling rate may be reduced if the solid CO_2 is left in one piece or if the slabs are placed together. For further reduction of cooling rate, cover the dry ice with an insulating cloth. In applying such coverings, care must be taken to prevent blocking air circulation within the chamber. When inserting solid CO_2 into the chamber, make certain that it goes far enough into the cavity so that it does not interfere with the installation of the test tray into the chamber by orienting the tray carefully and sliding into the chamber opening. Both toggle latches should then be depressed. When the tray is properly located, the latch will match the mating button and secure the tray in place. If not properly positioned, the tray gasket may interfere with the outer cabinet and the latch will operate stiff. A firm thumb pressure should be sufficient to operate the latch. A maximum force of 40 pounds is allowable on the clamp, greater forces will damage the clamp. Setting the MODE switch to cooling position and the SET POINT to the LOW position after turning on the POWER switch, should result in the chamber blower operating and air circulation. The chamber ambient temperature can be established by rotating the thermoswitch in a counterclockwise direction until a stop is met. The knob should be turned back about two revolutions in the opposite direction until the HEAT pilot glows. A click will be heard from the control relay at the same time. The thermoswitch is now set at slightly above chamber ambient. Setting the thermoswitch knob for the desired low temperature consists of turning the knob counterclockwise and remembering that approximately 90°F (33°C) per revolution is the approximate calibration of this thermoswitch.

For temperatures that do not differ greatly from that of the room, it is desirable to make the initial settings somewhat short of the desired value to prevent overshoot. In adjusting the thermoswitch, it is necessary to position the SET POINT to the LOW position so that control heat can be added to the system.

At the extreme low temperature rating of the chamber, it will be necessary to add heat for control of temperature. At the conclusion of a cold run, the POWER switch should be turned OFF and the test tray removed from the chamber along with the solid CO_2 container. To avoid excess collection of moisture after protracting cold runs, the chamber insulation should be dried by running the chamber at approximately 350°F for a period of one hour. This should also be done in humid climates, since insulation efficiency decreases when wet.

2.23 Cooling using Liquid CO_2

Utilization of liquid CO_2 is similar in principle to the solid CO_2 method, except no heat input is required to maintain a control point. It is possible by utilization of the heat control relay, to energize a solenoid valve when heat is not called for. Thus, an opposite function of heat (cold) is derived. The solenoid valve is used to inject liquid CO_2 in such quantity so as to refrigerate the test region. An extremely rapid rate of heat exchange is possible, when utilizing liquid CO_2. High pressure liquid CO_2 is required to operate a chamber so equipped.

NOTE: Those chambers equipped for liquid CO_2 operation have a B suffixed model number. The initial set up of a bottle or container of liquid CO_2 is simple. The first procedure is to position the bottle in a convenient and safe location. If safety chains are not available, it is advisable to wire or tie the container into an upright position.

CAUTION: The container must be a syphon tube container. If the container is not the syphon type, the liquid CO_2 within the bottle is not available to the user, since the liquid exists at the lower portion of the bottle and the gaseous CO_2 exists at the upper portion of the bottle. If such a bottle is encountered, the liquid can be used by inverting the bottle. Loose scale and rust within the syphon tube and the bottle should be blown out by cracking the valve slightly before connecting the hose assembly.

Connections to the bottle are made by means of the flexible hose and adaptor assembly supplied with the chamber. The threaded fitting on the flexible hose is connected to the threaded fitting on the chamber and the adaptor assembly is positioned on the bottle with the fiber gasket placed on the face of the connection. This joint can be a source of leaks and should be clean on both sides of the gasket and the mating surfaces. After the foregoing has been completed, it is only necessary to set the MODE switch to the liquid CO_2 position and the SET POINT to the OFF position. The POWER switch can be turned to the ON position and the subsequent circulation of air begins. Determination of the chamber ambient point is made by rotating the thermoswitch to the counter-clockwise direction until a stop is met, then turning in the clockwise direction for approximately two revolutions until the COLD lamp extinguishes. At this point, the setting of the thermoswitch corresponds to the temperature read on the thermometer and the chamber ambient. It is then necessary to rotate the thermoswitch in a counter-clockwise direction until the desired operating temperature is set up. Bear in mind that one rotation of the thermoswitch

2.23 Cooling using Liquid CO_2 (continued)

is equal to approximately 90°F (33°C). On those settings near the chamber ambient, it is advisable to set the thermoswitch slightly under the desired temperature so that overshoot does not occur. It is advisable when loading the test tray, that particular attention be given to the snugness of fit of the test tray and that all unused openings be plugged. In order to conserve liquid CO_2, it is also advisable to utilize masking tape around the edges of the tray. After a protracted run with liquid CO_2, a certain amount of moisture will have collected and condensed in the form of snow and frost within the chamber. It is then necessary to operate the chamber for a period of approximately one hour at +350°F. This will drive all moisture out of the chamber and out of the chamber insulation. Remember that insulation is not efficient when it is damp. Every precaution has been taken to seal the insulation completely, but minute leaks will occur with use; thus the insulation must be dried occasionally.

2.24 Cooling using Liquid and Solid CO_2 in combination

After loading the chamber with solid CO_2 (2.22), liquid CO_2 can be utilized for a fast draw-down to the operating temperature - thus providing good economy. If the chamber is to operate at the low end of the temperature range, liquid can be employed to maintain at the low end after the solid CO_2 has been consumed. Liquid CO_2 is injected by adjusting the thermoswitch (2.23), setting the MODE switch to Liquid CO_2, and position the SET POINT to OFF. After the desired temperature is reached, the MODE switch and the SET POINT are placed in dry ice and LOW, respectively.

2.3 External Cycling

Programmed control is possible by means of inter-connection into the jumper plug located on the control panel. This plug is labeled EXTERNAL. Reference to the schematic diagram within this manual is invited. Pins 1 and 2 on this connector (J101), are devoted to provision of line or instrument power (115 volts, 50-60 cycles, single phase). Pins 3 and 4 are jumpered and will provide external cycling control to the solenoid valve and cooling lamp. Pins 5 and 8 are likewise jumpered and can be employed to provide control of the solenoid valve. For example, if an external controller is used which is the contact making type (Brown, Leeds and Northrup, Bristol, etc.). Connection from Pin 1 of J101 to one side of a contact and connection of No. 8 on J101 to the other side of a contact, will provide cycling action of the solenoid valve. The contact must

2.3 External Cycling (continued)

close on temperature rise so that a low temperature can be maintained. In the same fashion, heat control can be achieved by series connection between Pins 2 and 9 on J101. The jumper connection between Pins 7 and 9 must be removed. In this instance the thermoswitch should be set beyond the range of activity so as to remain continuously closed.

CAUTION: The thermoswitch must be turned fully counter-clockwise when external control is being used.

Pins 10 and 11 on J101 can be utilized for the purpose of applying reduced voltage to the heater strip. For example, a dropping resistor of the proper wattage may be employed to reduce the input or a variable auto transformer can be utilized between Pins 10 and 11 and the AC return side of the input power connector for this service. Programming is possible by the use of two timers, and a second thermoswitch in the circuit between Pins 7 and 9. It is necessary, of course, to rearrange the circuit in such a fashion that the timers call in the proper thermoswitch at the proper time. In this fashion, two set point temperatures can be maintained and timer selection will occur between these two thermoswitches. In the instance of a secondary thermoswitch of this type, it will be necessary to modify the chamber or insert it in the tray region.

3.0 MAINTENANCE

Every effort has been made to provide a high quality product. Certain minimum maintenance procedures are suggested and when followed, will result in a long, trouble free life for the chamber.

3.1 Insulation

The insulation is sealed both from internal and external accumulation of moisture; however, moisture will accumulate after a sustained period of cold operation due to pin holes in the sealant material. The effect is a loss in insulation efficiency which tends to increase the cooling time and reduces the holding time at low temperatures. To restore the original properties, the insulation may be dried by operating the chamber at approximately +350°F for at least one hour with all access holes open. In continuous cold operations, at least one hot run a week will be found desirable. For best results, alternate hot and cold runs wherever possible.

3.2 Motor

The motor bearings are shielded ball bearings and permanently lubricated at the time of manufacturing. No additional lubrication is required during the life of the bearing.

3.3 Electrical System

The fuses used in the electrical system are noted below. The control relay will ordinarily last for the life of the chamber, however, occasional examination of contacts will indicate whether the relay is in a servicable condition. A table of replaceable parts is given in Section 5.0.

The thermoswitch may fail on occasion and will require replacement. It is recommended when changing temperatures, if the change is great, to make two adjustments of the thermoswitch rather than one. By doing this in steps, the thermoswitch is subjected to less stress, thus prolonging its life. See Technical Notes.

FUSE CHART

All Fuses Are Buss Fusetron FNM

Model	Line Fuse (amperes)	Heater Fuse (amperes)
TC-2	8	7
TC-4	20	15
TC-6	8	7
TC-8	20	15

4.0 CONTROL CIRCUIT

4.1 Description

The control circuit illustrated on the enclosed schematic drawing is suitable for the particular test chamers covered by the serial numbers indicated at the front of this manual. The control circuit is an anticipator controller which provides discrete control of the heat input or the discrete control of a solenoid valve, depending on whether a heat or cold run is being used.

It is notes that Fuse 1 (F-2), is the LINE fuse and is the first subject of examination on failure. It is further noted, that Fuse 2 (F-1) is the HEATER fuse and should be examined when the chamber cools properly but refuses to heat. After

4.1 Description (continued)

turning the power switch to the ON position, the control relay (1CR) is energized when the thermoswitch (THS-1) is closed. The thermoswitch closes on a temperature rise. Power is provided to the heaters when the thermoswitch is open, by virtue of the normally closed contacts on the control relay. If the SET POINT switch is in the OFF position, no heat will be provided to the heater assembly. In any other position, heat will be supplied to the heaters provided that the heater fuse is in good condition and that the external connection plug is plugged into the front of the unit. In the event liquid CO_2 is utilized, the circuit will provide for opening of the solenoid valve (SV) when thermoswitch is closed through the normally open contacts of the control relay and if the MODE switch (S-2) is positioned to the number 3 position so that the solenoid may be energized. The anticipator heater is energized at the same time the heater assembly is energized. This anticipator action provides approximately 2°F off-set in the TC-2 and TC-6 Models and approximately 4°F off-set on the TC-4 and TC-8 Models.

5.0 TROUBLE SHOOTING CHART

FAILURE OF POWER PILOT TO OPERATE WHEN POWER SWITCH IS ON

1. The power cord not plugged into power source.
2. Defective power switch (S-1).
3. Defective line fuse (F-2).
4. Defective power indicator lamp.
5. Defective power cord.

CHAMBER REFUSES TO HEAT

1. Line fuse faulty (F-2).
2. Faulty control relay (1CR).
3. Faulty thermoswitch (THS-1).
4. J101 (external connection) not plugged in.
5. Heater fuse open (F-1).
6. SET POINT switch not in High or Low position (S-3).
7. Defective heater.
8. Defective heater cable.
9. Defective shunt capacitor on thermoswitch.

FAILURE OF CHAMBER TO CONTROL (RUN-AWAY)

Assuming the chamber is put into a heating condition with the MODE switch and the SET POINT switch arranged properly for a heating run and that rotation of the thermoswitch fails to provide control of the heaters.

FAILURE OF CHAMBER TO CONTROL (RUN-AWAY) (continued)

1. Faulty thermoswitch (THS-1).
2. Faulty control relay (1CR1).

FAILURE OF SOLENOID VALVE TO OPERATE WHEN THE MODE SWITCH AND SET POINT SWITCH ARE ARRANGED FOR A RUN WITH LIQUID CO_2

1. Faulty thermoswitch (THS-1).
2. Faulty control relay (1CR1).
3. Faulty solenoid valve (SV).
4. Faulty mode switch (S-2).

FAILURE OF HEATING LAMP TO OPERATE WHEN HEATER WORKS PROPERLY

1. Defective heater indicator lamp.
2. Defective indicator lamp series resistor.

FAILURE OF COOL LAMP TO OPERATE WHEN CHAMBER OPERATES OTHERWISE PROPERLY ON A COLD RUN

1. Defective indicator lamp.
2. Defective indicator lamp series resistor.

DRIFT ABOUT CONTROL POINT

1. Open transformer (T-1).
2. Open anticipator winding on cable.
3. Defective thermoswitch

LINE FUSE OPENS WHEN POWER SWITCH IS TURNED ON

1. Defective (grounded) heaters.
2. Defective (shorted) heaters.
3. Defective motor (shorted).
4. Defective solenoid valve (shorted).

FAILURE OF SOLENOID VALVE TO CLOSE WHEN CHAMBER IS SET UP FOR LIQUID CO_2 RUN

1. Improperly adjusted thermoswitch.
2. Defective valve spring.
3. Defective valve seat.
4. Dirty valve seat.
5. Shorted shunt capacitor across thermoswitch.
6. Defective thermoswitch (shorted).
7. Defective control relay (welded contacts).

FAILURE OF SOLENOID VALVE TO OPEN, WHEN CHAMBER IS SET UP FOR LIQUID CO_2 RUN

1. Thermoswitch improperly adjusted.
2. Mode switch improperly set.
3. Mode switch defective.
4. Open solenoid valve coil.
5. Sticking valve.
6. Defective valve washer (swollen).
7. Defective control relay.

FAILURE TO CONTROL AT A LOW TEMPERATURE, WHEN CHAMBER IS SET UP FOR A LIQUID CO_2 RUN

1. Bottle valve not open.
2. Lack of liquid CO_2.
3. Clogged filter screens.
4. Clogged orifice.
5. Clogged valve.
6. Defective thermoswitch.
7. Clogged line.
8. Open control relay coil.
9. Defective control relay contacts.
10. Defective mode switch.
11. Improper setting of mode switch.
12. Open solenoid valve.
13. Defective valve washer.

EXCESSIVE SNOW & FROST IN CHAMBER WHEN USING LIQUID CO_2

Generally a small amount of frost and snow is not objectionable; however, if excessive amounts accumulate, it may be due to aspiration of external (ambient) air. This condition is aggravated in humid climates. Reduced air circulation can contribute to excessive amounts of frost and snow. The blower screen and the blower impeller may suffer clogging from foreign objects, and excessive snow may result. It is advisable to keep leaks around the test tray at a minimum.

REPLACEMENT PARTS PRICE LIST

(ALL PRICES ARE SUBJECT TO CHANGE)

NOTE: ALL REPLACEMENT PARTS WILL BE BILLED TO THE CUSTOMER. CREDIT FOR DEFECTIVE PARTS WILL BE ISSUED ONLY UPON RETURN OF THE DEFECTIVE PART TO OUR PLANT. IT IS IMPERATIVE THAT THE SERIAL NUMBER ON THE MACHINE TO BE REPAIRED ACCOMPANY THE REPAIR ORDER.

New Number	Old Number	Description	For Use With	Price
90004-039	731-010	Thermoswitch Assy.	BC-RC	43.00
90004-057		Orifice	BC-RC B Models	10.00
90004-074		T Fitting	BC-RC B Models	5.85
90004-168		Tube Assy. to Valve	BC-RC	2.50
90004-169		Tube Assy. from Valve	BC-RC	2.50
90004-173		Conversion Kit, Liquid CO_2	BC-RC A to B	75.00
90202-029		Spacer, Motor Sleeve	TC-2, 4, 5 & 9	1.05
90202-031	393-004	Bulkhead Fitting CO_2	All B Models	.70
90202-038	396-039	Switch, Mode	TC-2, 4	6.80
90202-046		Bushing, Motor Sleeve	TC-2, 4, 5 & 9	2.15
90202-055	731-008	Thermoswitch Assy.	TC-2, 4, 6 & 8	45.50
90202-067		Orifice, .022" CO_2	All TC Models	1.40
90202-090	532-001	Solenoid Valve w/Fittings	TC B Models	43.90
90202-091	532-004	Tube Assy. CO_2 Input	TC B Models	4.50
90202-093	553-002	Cable, Htr.	TC-2, 4	4.65
90202-094	553-001	Cable, Sensor	TC-2, 4	2.70
90202-095	562-001	Plug, Ext. Cross Connecting	All TC	5.35
90202-100	534-001/48	Hose Assy. 4' CO_2	All B Models	12.00
90202-101	534-001/96	Hose Assy. 8' CO_2	All B Models	16.50
90205-051	581-001	Amplifier PCA 100	TC-5, 9 & 15	125.00
90205-054	731-006	Sensor Assy. (Balco)	TC-5, 9 & 15	30.40
90205-055	531-001	Heater Assy. 900W	TC-5, 9 & 15	21.15
90205-078	396-045	Switch, Mode	TC-5, 9 & 15	12.45
90205-088	553-004	Cable, Heater	TC-5, 9	4.45
90215-052	553-010	Cable, Heater	TC-15	5.30
90304-117	396-004	Bushings, Hex.	Trays & Ovens	.25
90304-118	392-018	Spacer, Phenolic	TT-4/S,W, TT-8/S,W & TC-2, 4 Thermometer	.80 .80
90900-039	672-006	Conversion Kit, Liquid CO_2	A to B, 1958 to date	99.00
90900-040	672-009	Conversion Kit, Liquid CO_2	A to B, Pre-1958	110.00
93002-003	416-002/231	Resistor 230 Ω 1W	TC-5, 9 & 15	1.80
93002-004	416-002/251	Resistor 251Ω 1W	TC-5, 9 & 15	1.55
93002-005	416-002/341	Resistor 340 Ω 1W	TC-5, 9 & 15	1.50
93002-006	416-002/252	Resistor 2500 Ω 1W	TC-5, 9 & 15	2.20
93002-007	158-014/122	Resistor 1200Ω 20W	BC-RC-4	1.30
93008-001	165-001	Relay - Solenoid Control	TC-5, 9 & 15	8.00
93008-002	165-002	Relay - Power	TC-5, 9 & 15	12.95
93008-004	165-021	Relay - Power	TC-2, 4 & BC-RC	11.65

New Number	Old Number	Description	For Use With	Price
93008-005	165-026	Relay Motor - Starting 1/20 h.p.	All TC	1.85
93008-006	165-027	Relay, Motor Starting	BC-RC	2.05
93008-009	165-011	Relay - Delay Timing	TC-5, 9 & 15	5.50
93009-004	191-004	Plug 11 Pin Male w/Shield	TC-5, 9 & 15	2.90
93009-006		Plug, Female, Power	All TC & BC-RC	2.05
93010-001		Adapter, 3-4 Power Plug	Where required	1.45
93012-005		Switch, On-Off	All TC & BC-RC	2.65
93012-011		Switch, 10 Pos., 1 Deck	TCT-4/CR	9.40
93012-012		Switch, 15 Pos., 3 Deck	TCT-4/CR	58.00
93012-017	161-060	Switch, 3 Pos. Heat Select	TC-2, 4	8.70
93012-019	161-034	Switch Mode	BC-RC	5.60
93012-025	161-018	Switch CO_2 Mode	TC-5, 9 & 15	2.70
93013-003	179-010	Thermometer, -100°F.- +750°F.	TC-4, 5 & 9	24.70
93013-004	179-011	Thermometer, -100°F.- +350°F.	TC-2	22.70
93013-007	179-013	Thermometer-Contact -100°F.- +775°F.	TC-15	70.00
93015-001	171-001	Solenoid Valve Less Fittings	All B Models TC&BC-RC	37.95
93015-002	171-014	Valve CO_2 Repair Kit(O ring,plunger & spring)	All B Models	8.25
93015-003	171-003	Solenoid - Damper	All BC	8.95
93015-004	171-005	Solenoid - Damper	All RC	9.75
93018-001	167-005	Rectifier 25V	TC-5, 9 & 15	1.75
93019-003	166-004	Thyratron Tube	TC-5, 9 & 15	44.30
93021-001	170-001	Resolver - Bendix	Phasemeter	104.55
93022-002	160-001/500	Pot. 50Ω 2W	TC-5, 9 & 15	5.20
93022-006	160-002/501	Pot. 500Ω 10 Turn	TC-5, 9 & 15	30.55
93023-001	191-006	Fuse Holder	All TC	.65
93024-001	169-001	Lamp - Neon	All TC, BC-RC	1.85
93024-007	191-007	Lamp Holder	All TC, BC-RC	.95
93025-005	194-008	Knob - Thermoswitch	TC-2 & 4	1.85
93025-013	194-025	Knob - Thermoswitch	BC-RC	1.25
93028-010		O Ring, CO_2 Orifice	BC-RC B Models	.35
93030-001	173-022	Motor - 1/20 h.p.	All TC	41.00
93030-002	173-025	Motor - 35 m.h.	BC-RC	35.55
93032-001	134-012	Door Latch	All TC, BC-RC	3.50

New Number	Old Number	Description	For Use With	Price
93033-004	145-005	Handle, Tray	All TT Trays	.75
93034-022	140-005	Cork	All B Models	.03
93034-024	135-018	Washer, Fiber CO_2 Hose Assy.	All B Models	.05
93034-041	234-003	Bearing, Ball-Baldwin Motor	All TC (old)	2.60
93034-058		Plug, Dry Ice	Where required	5.20
93035-001	243-001	Scroll - Blower	All TC	3.90
93035-002	243-015	Blower Wheel	BC-RC	7.75
93035-003	243-004	Blower Wheel	All TC	4.05
93035-006	243-006	Blower, Double (Cooling)	TC-5, 9 & 15	28.75
93035-011	244-002	Fan, Ventilation 4" O.D.	BC-RC	2.50
93036-001	349-005	Gasket, Door Opening	TC-2, 4 & 15	6.80
93036-002		Gasket, Door Opening	TC-8 & 9	10.45
93036-003	349-009	Gasket, Tray	BCT,RCT-4/S,H,O & W	5.90
93036-005	349-003	Gasket, Tray	TT-4/S,H, O & W	9.15
93036-006	349-007	Gasket, Tray	TT-8/S,H, O & W	10.55
93037-001	312-001	Heater Strip, 500W	TC-2	8.45
93037-002	312-002	Heater Strip, 700W	TC-4	10.00
93037-003		Heater Assy. 450W	BC-RC-4	6.93
93038-001	349-011	Gasket, CO_2 Valve Mtg.	BC-RC	.15
93038-003	350-003	Screen, Filter CO_2 Hose	All B Models	2.50
93038-004	350-004	Reducer, Swivel (CO_2 Hose Assy.)	All B Models	2.50
93038-011	350-017	Nut, 5/16 CO_2 Bulkhead	All B Models TC & BC-RC	.25
93040-001	196-001	Power Cord - 8'	All TC, BC-RC	5.45
93040-002	348-001/48	Hose, CO_2 - 4'	All B Models	6.90
93040-003	348-001/96	Hose, CO_2 - 8'	All B Models	11.25
		Manual, Instruction	TC-2 & 4	3.50
		Manual, Instruction	TC-5, 9 & 15	3.50
		Manual, Instruction	BC-RC-4	3.50
		Manual, Instruction	TCT-4/CR	2.80
		Sealer, Hi-Temp. (Pint)	TC-4, 5, 9 & 15	2.50
		Sealer, Lo-Temp. (Pint)	TC-2	2.50
		Glue, Silicone (Door Gasket)	TC-2, 4 & 5	4.23

STATHAM INSTRUMENTS, Inc.
12401 West Olympic Boulevard
Los Angeles 64, California

PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

S-801-021

CHECK	LTR	ECN	DATE	REVISION	DWN
	D	1	11/23/61	REVISED & REDRAWN	
D.L. 5/8/61	E	365 & 680	5/8/61	1. S3 (DPDT) WAS: ROTARY SELECTOR SWITCH. 2. CHANGED CONFIGURATION OF ANTICIPATOR HEATER ON THS-1, & OF ICR RELAY 3. SEE ECN #365 & 680	

EXTERNAL

J101 FRONT
P101 REAR

RECEPTACLE-POWER INPUT 115 VAC

AC | COMMON

COPPER | TERMINAL

F2 LINE FUSE

S1 OFF

MOTOR M

STARTING RELAY

C1 .1 MFD 200 VDC

THS-1 THERMO SWITCH

SV CO_2 SOLENOID VALVE

COOL INDICATOR LIGHT

120 K 1/8 W.

R1 1200Ω 20W

RELAY 1CR

ICR2

ICR1 NORMALLY CLOSED

S2 MODE SELECTOR
1. HEAT
2. SOLID CO_2
3. LIQUID CO_2 (NOT USED ON "B" MODELS)

ANTICIPATOR HEATER ON THS-1

T-1

F1 HEATER FUSE

HEATER UNIT ASSEMBLY IN CHAMBER

HEAT INDICATOR LIGHT

S3 NORMALLY OPEN
HIGH
OFF
LOW

MODEL	F-1	F-2	1CR	SV
TC2A & TC6A	8 A	7A	DPDT	NO
TC2B & TC6B	8 A	7A	DPDT	YES
TC4A & TC8A	20 A	15A	DPDT	NO
TC4B & TC8B	20 A	15A	DPDT	YES
FUSES ARE BUSS FUSETRON FNM				

MODEL	SERIAL
TC2A & B	2-240 TO
TC4A & B	4-183 TO
TC6A & B	6-211 TO
TC8A & B	8-212 TO

NOTES

1. THS-1 THERMOSWITCH CLOSES ON TEMPERATURE RISE.

STATHAM DEVELOPMENT CORP
LOS ANGELES

MAYSON 11-27-61

CONTROL CIRCUIT TC2-TC4-TC6-TC8

S-801-021

S-801021 E

STATHAM INSTRUMENTS, INC.
12401 WEST OLYMPIC BOULEVARD
LOS ANGELES 64, CALIFORNIA

TECHNICAL NOTE #2

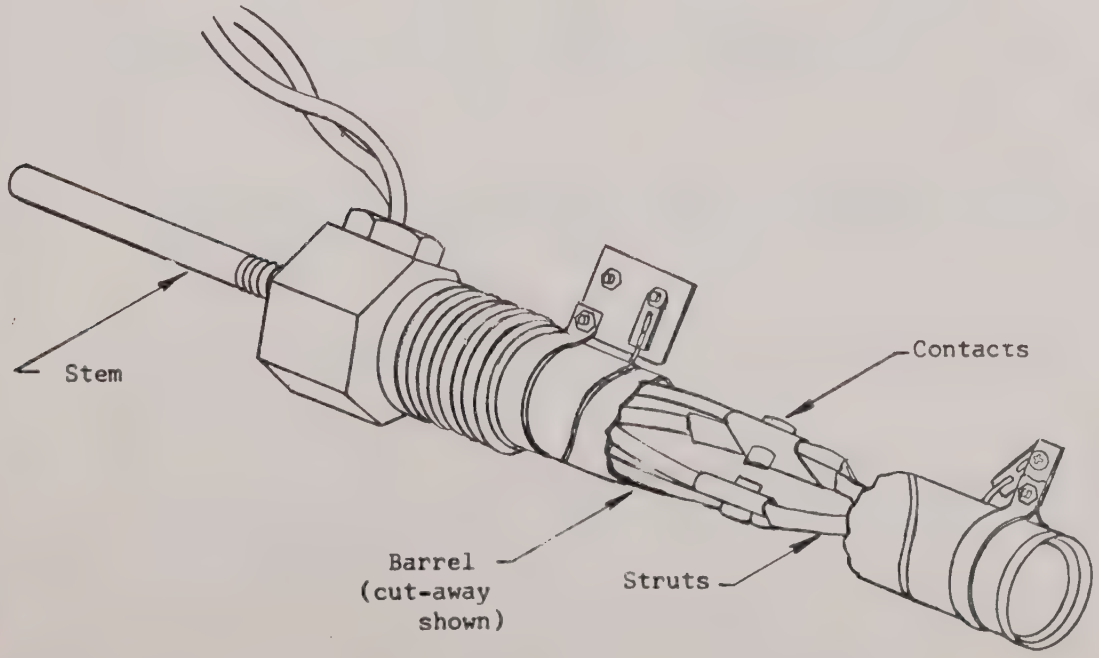
THERMOSWITCH ASSEMBLY USAGE

The thermoswitch is a sensitive electronic instrument and should be handled with extreme care. It is the primary control device in many models of the Statham temperature test chambers. The extremely high incidence of thermoswitch failure can be attributed to improper handling and thermoswitch abuse.

CAUTION

When a temperature chamber is at a high temperature, reduction in temperature to ambient or lower should be accomplished in discreet temperature steps or intervals in order to reduce the thermal shock to the internal struts of the thermoswitch. A single setting change from maximum to minimum temperature (high to low) over the entire range of the chamber will cause the thermoswitch to be subjected to a thermal shock greater than it can withstand.

The outside barrel is the most sensitive part of the entire assembly. A sketch is shown below of the structure of the thermoswitch and its assembly.



All rejected thermoswitches returned to Statham are examined under X-Ray and fluoroscope. Examination has revealed broken welds, over-stressed struts and adjustment stems removed or replaced. These things destroy the calibration of the thermoswitch and void the warranty.

Special Note: The adjustment stem on a thermoswitch has an inside and an outside thread which are coupled at the factory with a special jig fixture to calibrate the unit.

The following thermoswitch assemblies are listed with their histories (an assembly includes the anticipator heater, mounting plates, yoke and stops):

	Statham P/N	Fenwal P/N	Statham Ass'y	Temp. range F°.	Remarks
1.	not avail.	17100-138	not avail.	-100° to +350°	Use item 4 See note (g)
2.	not avail.	17102-22	not avail.	-100° to +600°	Use item 4 See note (g)
3.	not avail.	17121-0	not avail.	-100° to +350°	Use item 4 See note (g)
4.	93012-018	17123-0	90202-055	-100° to +600°	
5.	not avail.	17121-0	not avail.	-100° to +350°	Use item 6
6.	93012-018	17123-0	90004-039	-100° to +600°	

REPLACEMENT OF THERMOSWITCHES

CAUTION: DO NOT REMOVE OR ADJUST STEM OF THERMOSWITCH UNTIL AFTER INSTALLATION.

The thermoswitch is shipped complete and tested. It is not set for the maximum and minimum limit of the unit. To minimize failure rate of thermoswitches the following procedure is recommended:

(a) Remove knob and dial plate.

(b) After making sure that chamber is disconnected from line voltage, disconnect thermoswitch wires from circuit. Disconnect anticipator wires from mounting brackets on the barrel (3 wires for new units, 4 wires for older models).

(c) Working from inside the unit, remove sheet metal screws and #6-32 nuts on thermoswitch plate assembly.

(d) Install new unit in reverse order of (c) above.

(e) Connect thermoswitch assembly wires to correct pair of wires from control panel. This may be checked out by print or by ohmeter. One wire should go to one side of the power relay coil, and one wire to common side of line voltage.

(f) Anticipator wire or wires may be connected to brackets on the barrel. If a two wire circuit, it may be connected without discretion. If a one wire circuit, connect only to insulated end of anticipator.

(g) When replacing an old type thermoswitch (731-002 or -003) it will be necessary to rewire power relay contacts. Wires on normally open contacts should be connected to normally closed contacts and normally closed contact wires should be connected to normally open contacts. Alternatively, replace the power relay (P/N 93008-003) and connect according to print.

(h) Plug unit in to line source and set mode for heat. Note which light is on and adjust in a direction to turn on opposite light (clockwise movement calls for heat, counter-clockwise for coolant). Carefully turn thermoswitch clockwise (approximately 90° per turn) until chamber is controlled at its maximum temperature. Adjust rear stop bracket so that it is tight against stop collar on stem of thermoswitch. The same sequence should be used for adjustment of the cold cycle. It is imperative that the stop brackets be set at the operating limits in order to prevent damaging the thermoswitch.

CAUTION: When the temperature chamber is at high temperature, reduction to ambient or below should be completed in discreet temperature steps in order to avoid damage to internal struts of thermoswitch.

NOTE: If temperature chamber is "A" model, it is only necessary to adjust thermostat two full turns below ambient setting.

(i) Install dial plate and other pertinent hardware.

(j) Install knob.

(k) Unit should now be operational. Extreme care should be used in adjustment and operation of thermoswitches at all times.

STATHAM INSTRUMENTS, INC. No. 60-27

T E C H N I C A L B U L L E T I N Date May 8, 1961

Subject: Excessive Oil in Temperature Test Chambers

This bulletin is issued in response to the increasing number of inquiries regarding the excessive amounts of oil residue found in temperature test chambers. It is offered as information only, since at this time, the solution to the problem is pending investigation.

The oil in question seems to be restricted to release at the critical expansion stage of sublimation.

The oil being used universally in the manufacture of CO_2 is a white, light-bodied vegetable oil (viscosity of 0.16 centipoise).

The formula and analysis of the amount of oil needed to manufacture CO_2 is approximately 0.5 parts per million by weight; yet they have found as much as 50 parts per million when the CO_2 reaches the solid dry ice form.

The exact cause of this problem has not been determined. It is suspected, however, to be a result of emissable oils from mechanical compressors used in its manufacture and becoming a part of the end product. No existing means of filtering or treating the CO_2 have proven successful.

Manufacturers of carbon dioxide have been made aware of this situation by the increasing number of complaints received. As a result, they have undertaken an extensive investigation into the causes and solution of the problem.

It is advisable to remove all traces of oil residue from the chamber to minimize the possibility of smoke dispensation.

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